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(54) Device for capturing cockroaches

(57) Two types of cockroach trap are provided. One type comprises a bottom plate having an adhesive layer formed on the inner surface; a pair of side plates (3) connected to both lateral sides of said bottom plate; and a pair of end plates (4) connected to both end sides of said bottom plate, each of said side and end plates having a plurality of openings (9) which are longer in the direction normal to the bottom plate than in the direction parallel thereto. The other type is substantially the same as the first type except that an end plate (33) is connected to only one end of the bottom plate (27) and that each of said side plates consists of a wide portion (30) which is positioned close to the side where said end plate is provided and a narrow portion (28) which is positioned close to the other end where no end plate is provided.

Fig. 2

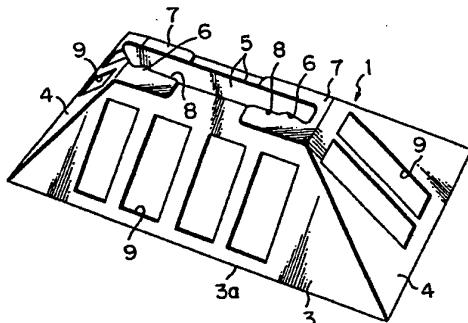
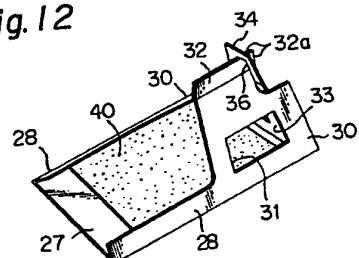


Fig. 12

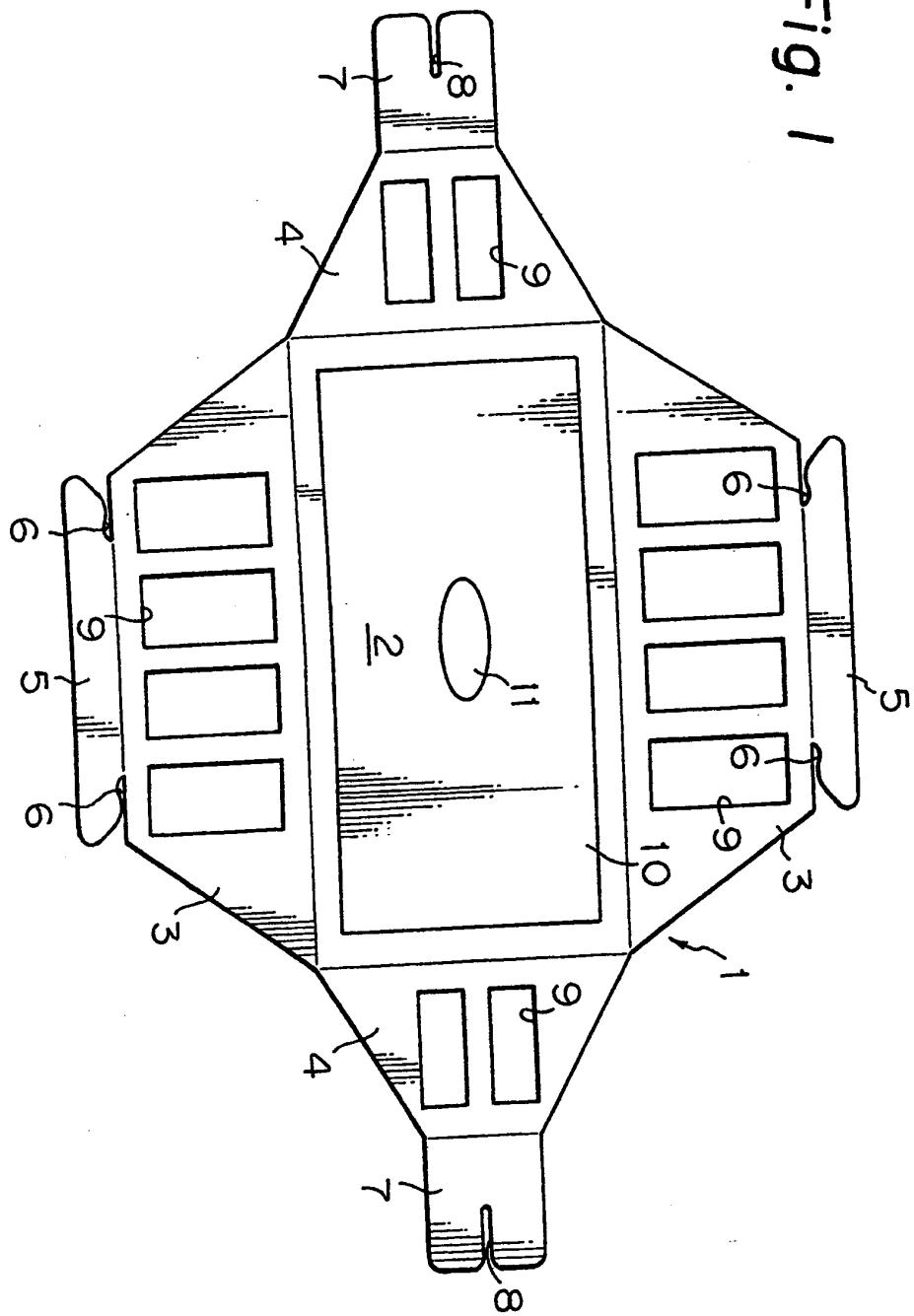


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Fig. 1



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Fig. 2

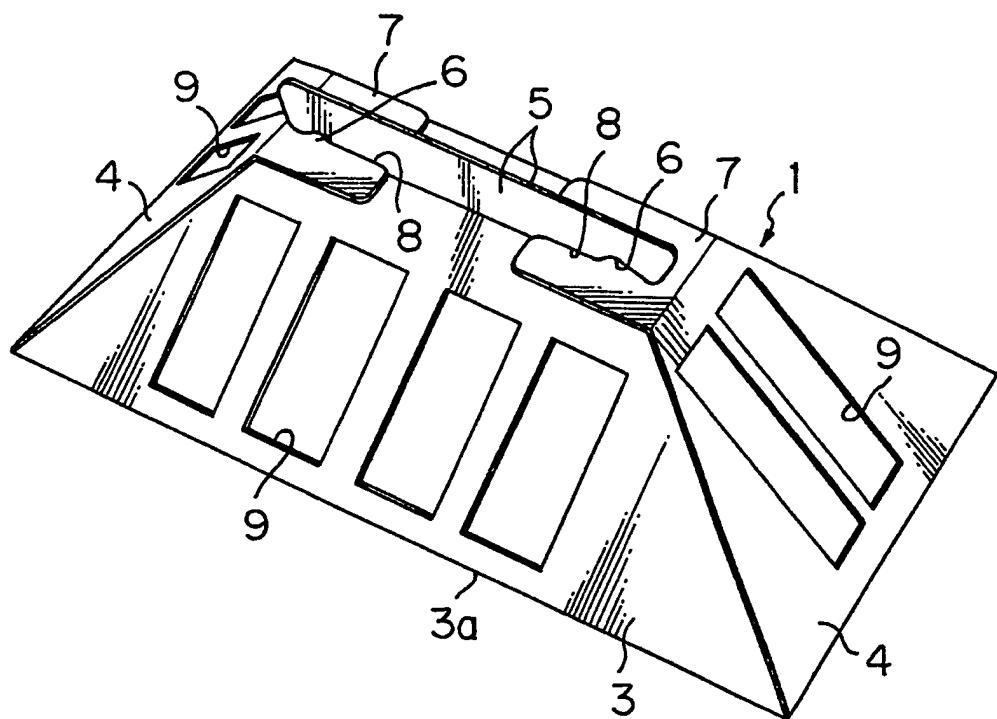
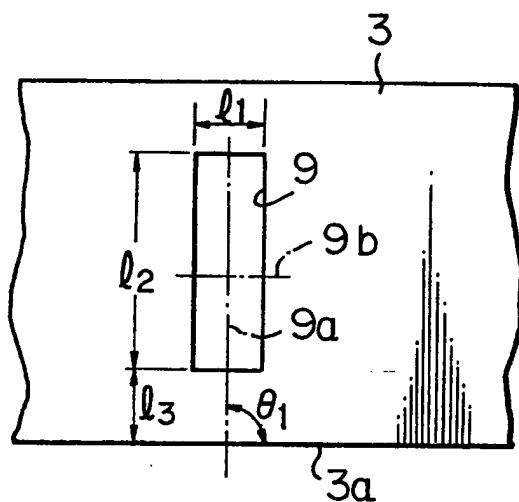


Fig. 3



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Fig. 4

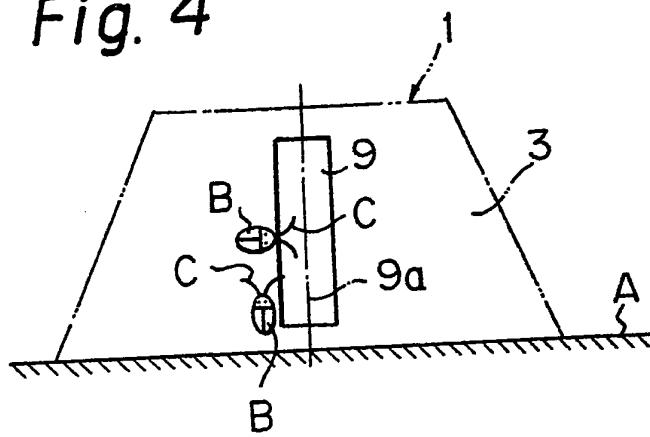


Fig. 5

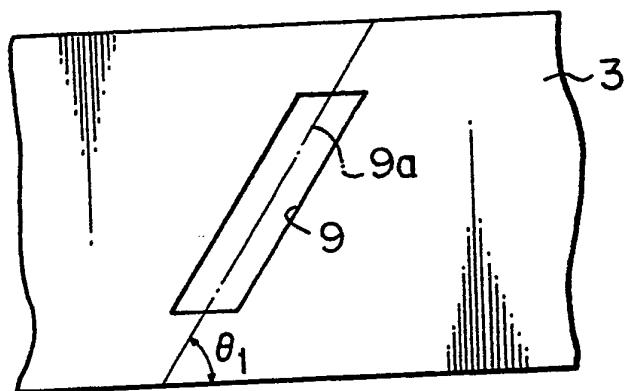
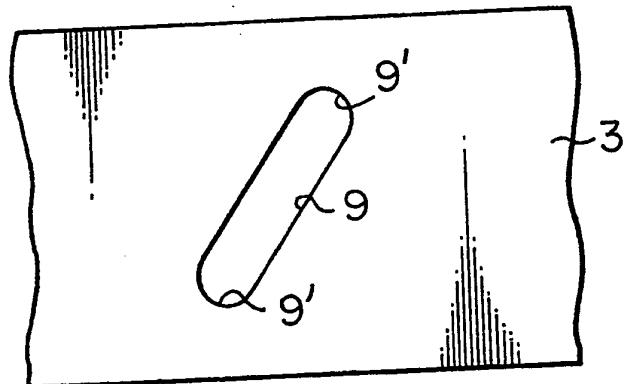


Fig. 6



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Fig. 7

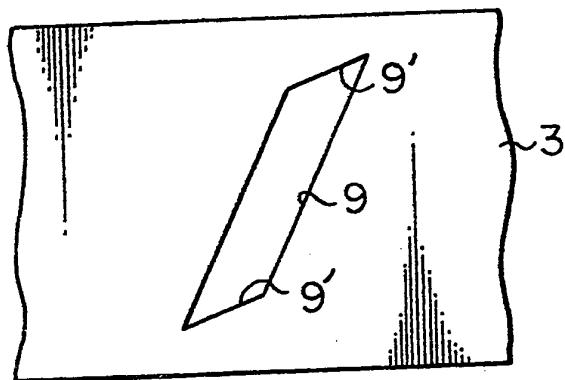


Fig. 8

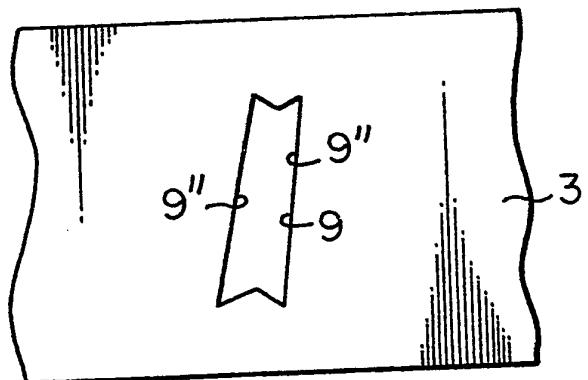


Fig. 9

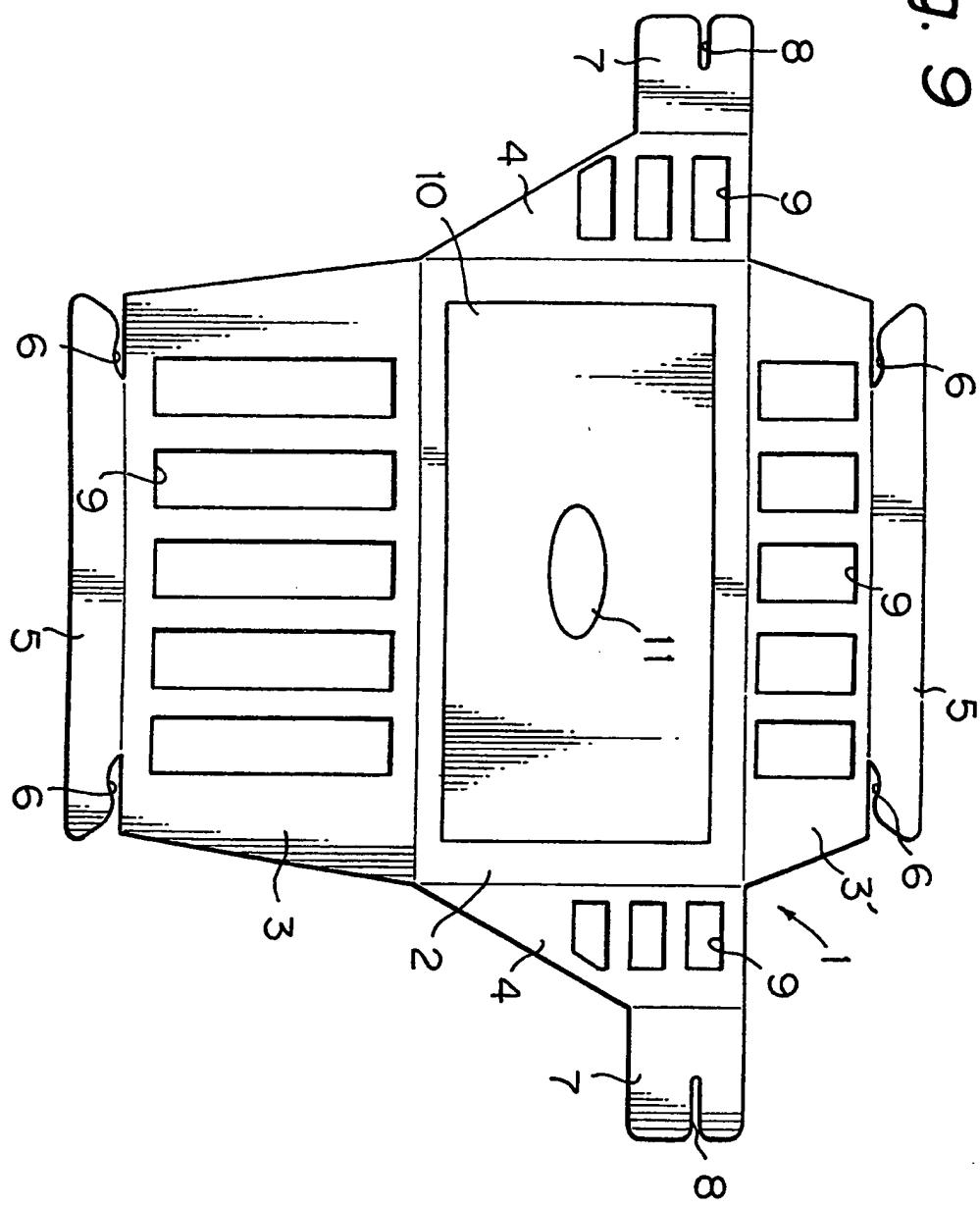


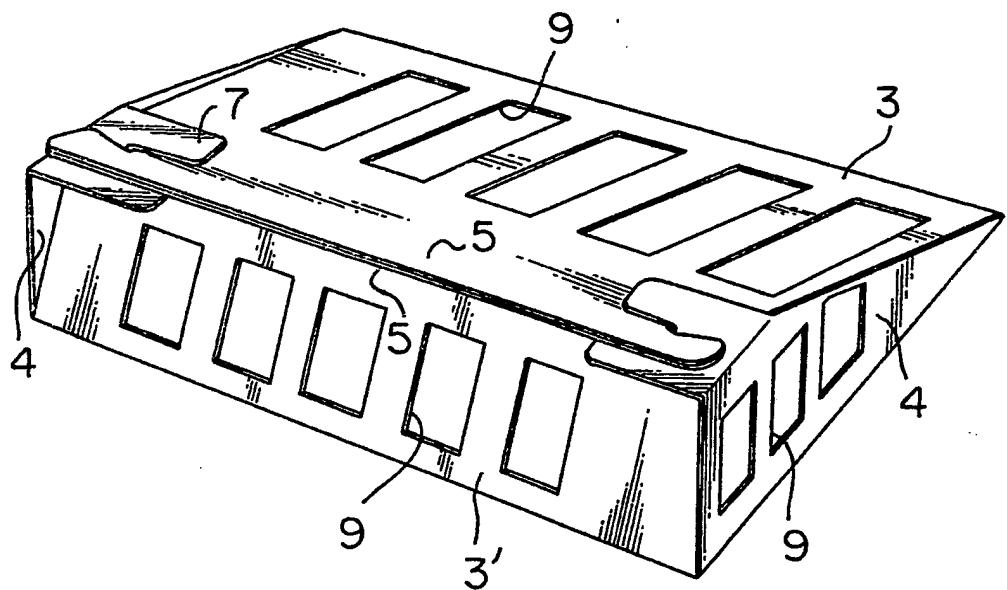
Fig. 10

Fig. 11

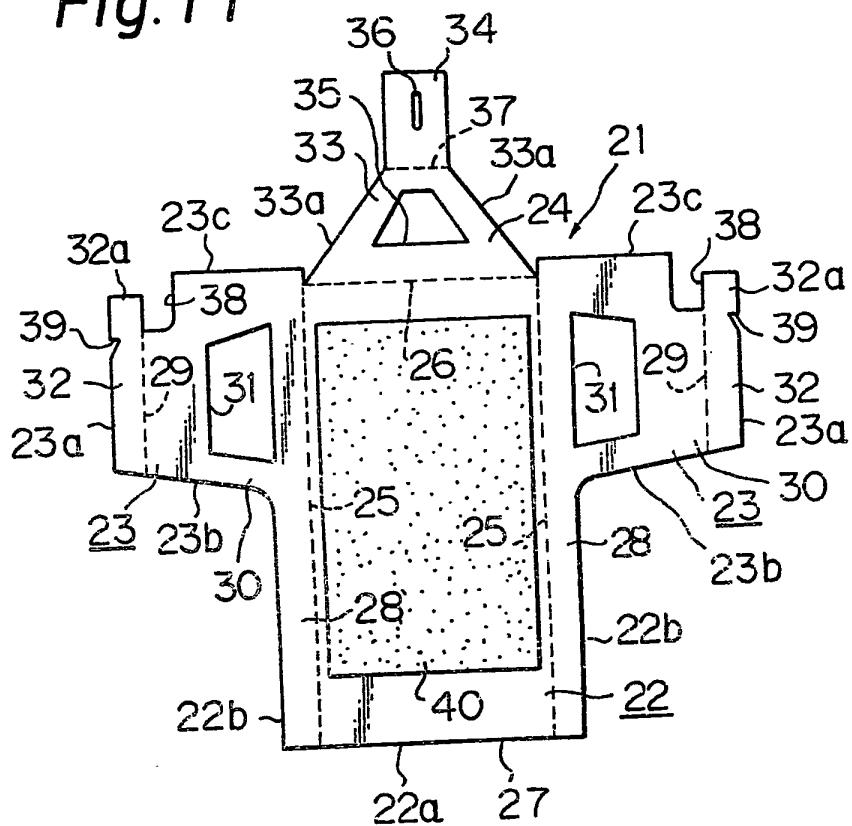
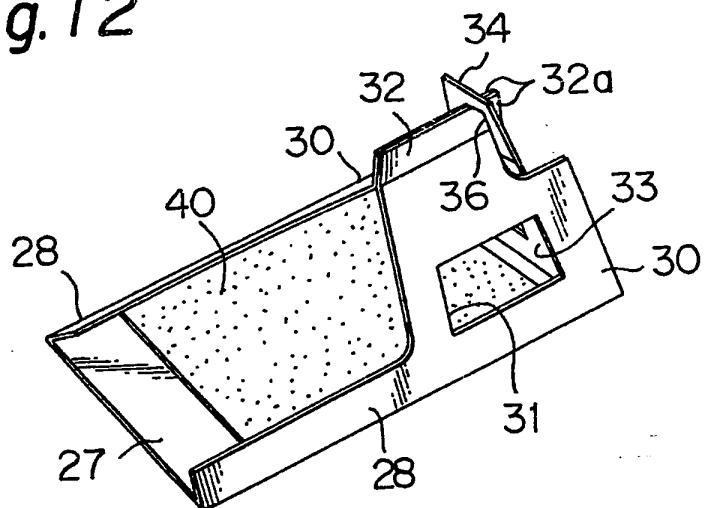


Fig. 12



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Fig. 13

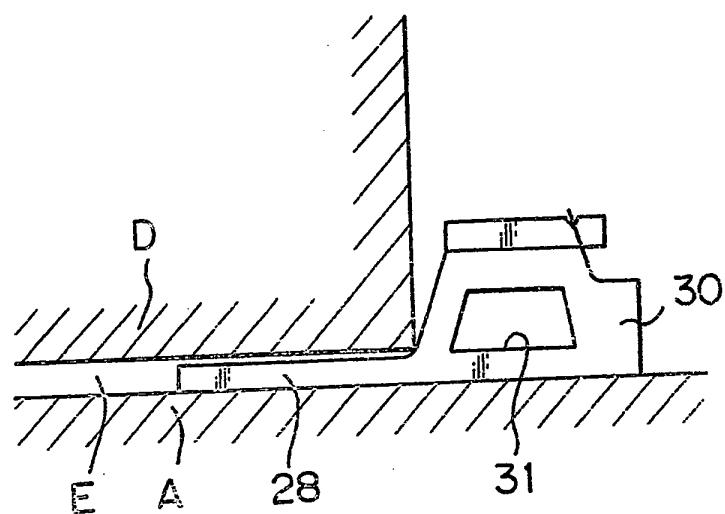
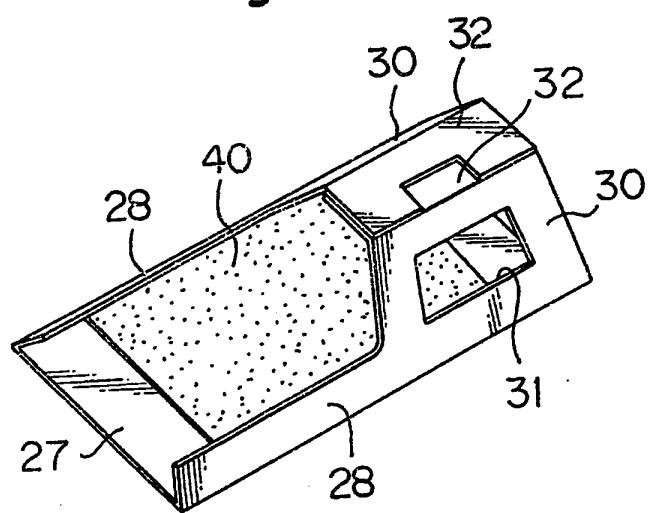


Fig. 14



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Fig. 15

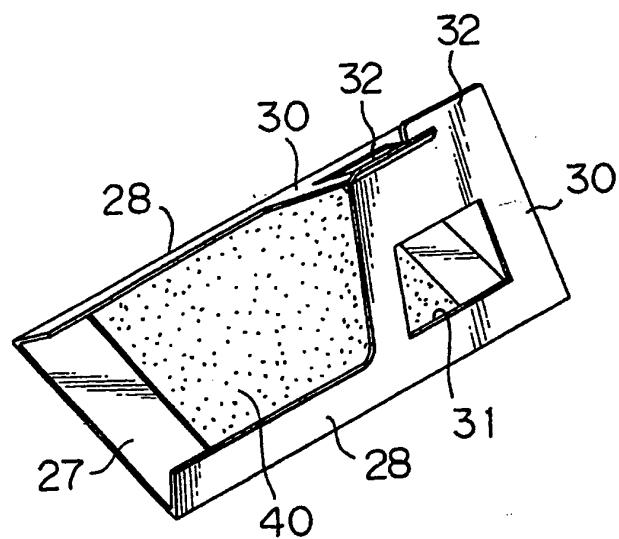
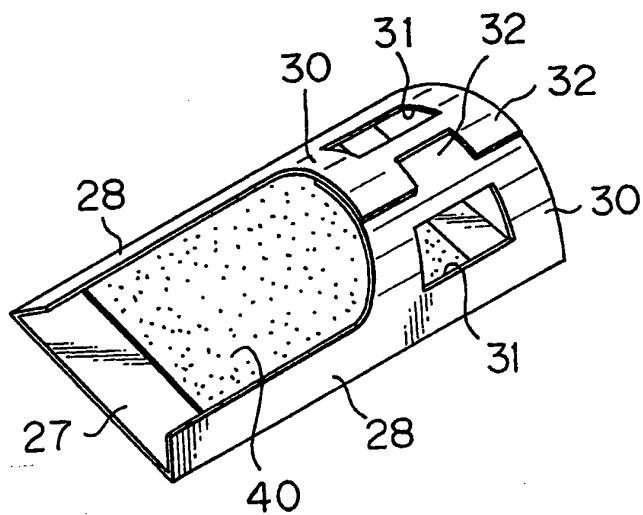


Fig. 16



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Fig. 17

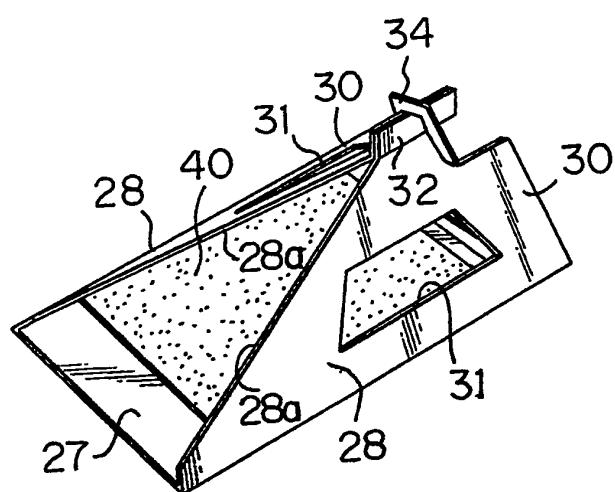
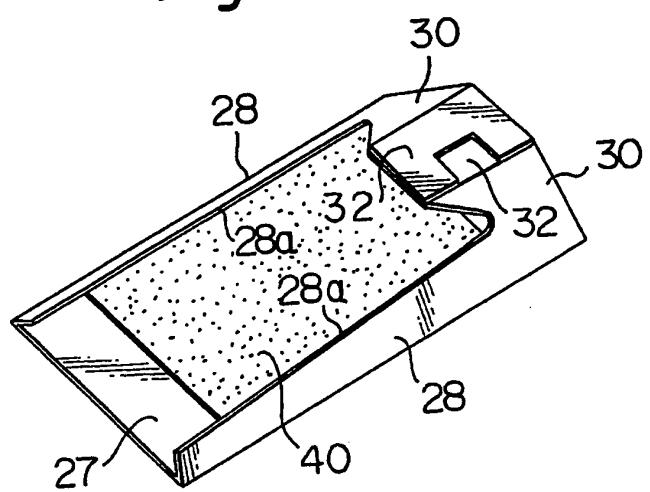


Fig. 18



SPECIFICATION

D vice for capturing cockroaches

5 The present invention relates to a d vice that capture cockroaches by stickiness whether they are within an open space or in a small concealed area. A conventional device for capturing cockroaches by stickiness comprises a box-like member which has a 10 layer of adhesive agent applied to the inner surface of the bottom, an attractant provided in the center of the adhesive layer, and openings provided in the surrounding box walls. A cockroach entering the box through an opening is captured by the sticky adhesive 15 agent and is unable to escape from the box. Conventionally, three types of openings are provided in the side walls of the cockroach trap. The first type is a generally rectangular opening which is longer in the direction parallel to the bottom member 20 than in the direction normal thereto. The second type is in the form of an inverted triangle. The third type is an opening which is directly connected to the bottom member.

The first type of opening is so large that the user can 25 see the inside of the trap and has an unpleasant feeling after cockroaches are captured. Furthermore, dirt and dust which easily get into the trap through the opening adhere to the adhesive layer and accelerate the deterioration of the adhesive agent. The effective 30 ingredients of the attractant evaporate quickly through the opening. As another disadvantage, the large opening permits easy access of the tentacles of a cockroach into the inside of the trap, so the cockroach easily senses the danger of the adhesive agent and 35 hastily gets away from the trap.

The second type of opening also permits easy access of the tentacles of a cockroach into the inside of the trap and impairs its performance by the same reason as shown above in connection with the first 40 type of opening.

With the third type of opening, the adhesive layer is directly exposed to the floor on which the trap is installed, so the adhesive agent is easily sensed by a cockroach. If a large cockroach is captured by the 45 forelegs, it will pull the device by its hind legs or escapes from the device, leaving the forelegs behind.

In order to solve the problems with the conventional 50 device for capturing cockroaches by stickiness, the present inventors made various studies on the behaviour of cockroaches and obtained the following observations. Being lured by the attractant in the trap, the cockroach comes close to an opening in the trap and senses first the exterior, then the interior of the opening by the tentacles. If the tentacles touches the 55 adhesive layer, it will not enter the device by sensing its potential danger. With the conventional device for capturing cockroaches by stickiness, it often occurs that only legs of adults or old instars of *Periplaneta fuliginosa* Serville are captured by the adhesive layer.

60 Cockroaches can easily enter a small gap (ca 5 mm) which extends vertically. They often go in and out of other forms of small gaps.

Another defect of the conventional box-shaped 65 d vice for capturing cockroaches by stickiness is that its height prevents installation in the gap between the

floor and a refrigerator or furniture such as a cupboard. In order to capture cockroaches living in such gaps, three types of d vice have been proposed. First type of the device consists of a thin flat sheet 70 coated with an adhesive agent. The second type is similar to the first type except that the thin flat sheet is provided with a curved piano wire as a fixing means. The third type is in the form of a box shape having a top sheet spaced by a small distance from the bottom member. These three types of the capturing device are sufficiently low in height to be installed within small confined areas.

However, the first type of the device which is in the 75 form of a flat sheet is vulnerable to external bending or twisting forces. Furthermore, the adhesive layer is not properly protected from environments, so the device cannot be freely pushed into or pulled out of the target area without causing the adhesive layer to stick to the bottom of furniture. The stuck adhesive layer cannot be easily detached from the bottom of the furniture without deforming the device. The flat sheet coated with an adhesive layer is so light in weight that it slips easily by a small force. A large cockroach which is 80 captured by only the forelegs will use its strong hind legs to drag the trap to a place which is not best fitted to the purpose of capturing cockroaches. While the cockroach is dragging the trap, the adhesive layer may sometimes foul the wall of the furniture. Furthermore, the device which is in the form of a flat sheet is difficult 85 to pull out of the gap between the floor and the furniture by hand. The only part of the device that can be held by the fingers is the adhesive layer to which cockroaches are stuck, but this is not recommendable from a sanitary viewpoint.

90 The second type of the cockroach trap effectively uses the piano wire to fix the device securely in the predetermined area of installation. However, as in the case of the first type of device, the adhesive layer may foul the wall of the furniture and the device can be 95 removed from the target area by only holding the filthy part where cockroaches have got stuck.

The third type of the capturing device has such a 100 small space between the top and bottom members that cockroaches have much difficulty to enter the device. It is also difficult for the user to check visually whether cockroaches have been captured in trap. Furthermore, this type of device which is in a box shape having both top and bottom sheets requires a 105 materials cost at least twice that necessary for making the first and second types of device.

The three types of cockroach trap shown above 110 have one common problem: they are basically intended for use in small gaps and cannot be used satisfactorily in an open space including a large floor.

115 Therefore, one object of the present invention is to provide a sanitary device for capturing cockroaches by stickiness that exhibits a high capturing efficiency and which retains the effectiveness of an adhesive agent and an attractant for a prolonged period.

120 Another object of the present invention is to provide a sanitary device for capturing cockroaches by stickiness that can be used not only in an open space but also in a small concealed area without being bent or twisted by external forces and without causing 125 contamination by the adhesive agent.

2 According to one aspect of the invention, a device for capturing cockroaches is provided, which comprises a bottom plate having a layer of an adhesive agent formed on the inner surface for capturing cockroaches; a pair of lateral side plates connected to the lateral sides of said bottom plate, each of said lateral side plates having a flap along its lateral side and having at least one opening which provides a passage for cockroaches to enter the device and which is longer in the direction normal to the lateral sides of the bottom plate than in the direction parallel thereto; and a pair of end plates connected to the end sides of said bottom plate, each of said end plates having a link member on its end portions that engages said flaps and having at least one opening which provides a passage for cockroaches to enter the device and which is longer in the direction normal to the ends of the bottom plate than in the direction parallel thereto, said device being constructed by folding said lateral side plates and said end plates at the lateral sides and ends of said bottom plate, connecting said flaps, and engaging the same with said link members at the ends thereof.

According to another aspect of the invention, a device for capturing cockroaches is provided, which comprises a bottom plate having a layer of an adhesive agent formed on the inner surface for capturing cockroaches; and a pair of side plates connected to the lateral sides of said bottom plate, each of said side plates extending to one end of said bottom plate and consisting of a wide portion having a flap at its lateral side and a narrow portion which is connected to the end of said wide portion and extending to the other end of said bottom plate, said device being constructed by folding said side plates at the lateral sides of said bottom plate and engaging said flaps with each other or bonding the same to each other.

Fig. 1 is a plan view of the blank from which a device for capturing cockroaches is made according to the first aspect of the present invention.

Fig. 2 is a perspective view of the device in its completed form.

Fig. 3 is an illustration showing the shape and size of an opening made in the device of the present invention.

Fig. 4 is an illustration showing how cockroaches are captured by the device of the present invention.

Figs. 5 to 8 are illustrations showing different embodiments of the opening made in the device of the present invention.

Fig. 9 is a plan view of the blank from which a device for capturing cockroaches is made according to a modified embodiment of the first aspect of the present invention.

Fig. 10 is a perspective view of the device in its completed form.

Fig. 11 is a plan view of the blank from which a device for capturing cockroaches is made according to the second aspect of the present invention.

Fig. 12 is a perspective view of the device in its completed form.

Fig. 13 is an illustration showing how the device of Fig. 12 is installed for capturing cockroaches.

Fig. 14 to 18 are perspective views showing

different embodiments of the device according to the second aspect of the present invention.

Various embodiments of the present invention according to its first aspect are shown below. Fig. 1 is a plan view of the blank for making a device for capturing cockroaches. Fig. 2 is a perspective view of the device in its completed form. The blank generally indicated at 1 is made of any material such as plastics, metals or paper. It consists of a rectangular bottom plate 2, side plates 3, 3 connected to both lateral sides of said bottom plate, and end plates 4, 4 which are connected to both ends of said bottom plate. Each side plate 3 is inclined on both ends and has a flap 5 formed on the lateral side. Both ends of each flap 5 are spaced from the lateral side of the side plate 3 to form a gap 6 therebetween.

Each end plate 4 is inclined on both lateral sides and has a link member 7 connected at its end portion. The link member 7 has a slit 8 open to its end portion.

Each side plate 3 is provided with at least one opening 9 which is longer in the direction normal to the lateral side of the bottom plate 2 than in the direction parallel thereto. Each end plate 4 is also provided with at least one opening 9 which is longer in plate 2 than in the other direction. A layer of adhesive agent 10 is formed on the inner surface of the bottom plate 2. The adhesive layer 10 is preferably covered with the peelable paper which is peeled before use, adhesive layer.

The side plates 3 and end plates 4 are folded respectively at the lateral sides and end portions of the bottom plate 2. The two side plates 3, 3 are brought into contact with each other and the opposing faces of the flaps 5, 5 are put together and the slits 8 in the link members 7 are brought into engagement with the gaps 6, thereby constructing a device for capturing cockroaches by stickiness, which has the adhesive layer formed on the inner surface of the bottom plate 2 and has openings 9 made in the surrounding walls.

As shown in Fig. 3, each opening 9 made in the side plate 3 is in the form an elongated rectangle having the following dimensions: the length l_1 of the axis 9b normal to the axis 9a that bisects the opening in the longitudinal direction is preferably not less than 5 mm but not more than 12 mm; the longitudinal axis 9a is inclined with respect to the line 3a (at which the side plate 3 is folded) at an angle θ_1 , which is preferably in the range of 30° to 150°, typically 90° as in Fig. 3; the length l_2 of the longitudinal axis 9a is preferably at least 1.5 times the length l_1 of the transverse axis 9b; and the opening 9 is spaced from the fold line 3a by a distance of 5 mm or more.

The opening 9 may assume other configurations. For example, the opening may be inclined in such a manner that the longitudinal axis 9a forms an angle θ_1 of 30° to 150° with the fold line 3a, as shown in Fig. 5. The short sides 9', 9' of the opening need not be parallel to the fold line 3a and may assume such shapes as shown in Figs. 6 and 7. Alternatively, the long sides 9'', 9'' of the opening need not be parallel to each other and may assume such a shape as shown in Fig. 8.

130 The foregoing discussion about the size and shape

of the opening 9 may equally apply to that made in the end plates 4.

A modified embodiment of the device according to the first aspect of the present invention is shown in Figs. 9 and 10. In the embodiment of Figs. 9 and 10, one side plate 3 is broader than the other side plate 3'. One side wall of each end plate 4 has a length equal to the end portion of the broad side plate 3, and the other side wall of each end plate has a length equal to the end portion of the narrow side plate 3'. When the device is set up, the broad side plate 3 forms a smaller angle with the bottom plate 2 than does the narrow side plate 3' as shown in Fig. 10.

In an embodiment not shown here, a device may be produced by using relatively high side plates and end plates, provided that one side plate is erected at a right angle with respect to a relatively narrow bottom plate. This type of device is particularly suitable for capturing cockroaches living in a small concealed area.

As shown in Fig. 4, when a cockroach B climbs the one of side plates 3 of the device 1 placed on a floor A, it tries to enter the device through an opening 9 by first putting its tentacles C into the opening. Since the opening is longer in the direction normal to the bottom plate than in the other direction, the pair of tentacles C, C cannot be easily put into the opening unless they are perpendicular to the floor A. This causes the cockroach B to assume a posture that is generally normal to the longitudinal axis 9a of the opening 9. As a result, the cockroach gradually crawls up the side plate 3 and spreads its tentacles C into the opening so that they are substantially parallel to the axis 9a.

After using the tentacles C to confirm that there is no danger on his way, the cockroach puts its head into the device through the opening. Since the adhesive agent 10 is in the right (or left) position, not above or below, with respect to the head of the cockroach, it senses no danger and puts its breast or abdomen past the opening 9. Then, in order to keep the balance of his posture, it extends the forelegs downwardly in the direction of gravity, whereupon the legs are stuck to the adhesive layer 10.

Being scared, the cockroach tries to escape from the trap. However, the greater part of his body is already within the device 1 and its movement is limited by the unique configuration of opening 9 which is longer in the direction normal to the bottom plate than in the direction parallel thereto (i.e., the transverse axis 9b whose length l₁ is in the range of 5–12 mm prevents the free movement of the cockroach that has approached the opening in a posture generally normal to the longitudinal axis 9a). In addition, more than half of the six legs of the cockroach are within the device and as it wriggles about, the hind legs are also captured by the adhesive agent 10.

The device of the present invention having openings of the shape and size specified above is particularly effective for capturing large cockroaches such as American cockroaches and *Periplaneta fuliginosa* Serville whether they are adults or old instars. The device of the present invention is also effective in capturing small cockroaches such as German cockroaches and young instars of other species because their tentacles are short and are less fit for the purpose.

of sensing the danger of the adhesive agent present on the bottom of the device.

Therefore, the device of the present invention is capable of effectively capturing all kinds of cockroaches. Once the cockroach is trapped by the adhesive layer on the bottom plate of the device, it finds much difficulty in finding the way out by putting the tentacles out of the device through the opening which is longer in the direction normal to the bottom plate than in the direction parallel thereto unlike the opening used in the conventional device which is longer in the direction parallel to the bottom plate than in the other direction. Even if it succeeds in escaping from the adhesive layer by separating the legs stuck to the adhesive layer, the cockroach is again captured by the adhesive layer before it finds the way out. This is another factor that enhances the efficiency of capturing cockroaches.

The use of openings 9 which are longer in the direction normal to the bottom plate than in the direction parallel thereto enables the fabrication of a capturing device whose width is sufficiently small to permit installation in a small gap between two closely spaced pieces of furniture. The device needs no separate roof or canopy to conceal its interior; the device does not give any unpleasant feeling to the user and if necessary, he can look into it to see whether cockroaches have been captured. Furthermore, the device can be kept dark so that it provides a condition liked by cockroaches. As another advantage, the device of the present invention permits less draft than a conventional device having a single large opening in each of the side plates. Therefore, dirt and dust have a smaller chance to build on the surface of the adhesive layer, and the adhesive agent remains sufficiently effective for an extended period. The life of the attractant positioned in the center of the adhesive layer is also extended because the effective ingredients of the attractant are held in a favorable atmosphere.

Various embodiments of the device for capturing cockroaches according to the second aspect of the present invention are hereunder described by reference to Figs. 11 to 18. Fig. 11 is a plan view of the blank 21 making a capturing device according to this second aspect. Fig. 12 is a perspective view showing the completed form of the device. The device generally indicated at 21 is in the form of a thin sheet made of any material selected from among paper, plastics and metals. The blank having the shape shown in Fig. 11 is prepared by a suitable means such as a press, and folded in a predetermined manner to make the completed form shown in Fig. 12.

As shown in Fig. 11, the blank 21 is generally in the form of a "cross" which consists of a center member 22, a pair of wings 23, 23 and a wing 24. A fold line 25 is formed on both lateral sides of the center member 22, and another fold line 26 is formed between one end of the center member 22 and the wing 24. A rectangular portion defined by the fold lines 25, 26 and the other end 22a of the center member 22 provides a bottom plate 27. A first side plate 28 is defined between each lateral side 22b of the center member 22 and each fold line 25.

Both wings 23, 23 are shorter than the center

member 22 and integral parts thereof which are positioned closer to the end of the center member which is connected to the wing 24. A fold line 29 that runs across the ends 23b and 23c of each wing 23 is provided at a position closer to the lateral side 23a. The area defined between this fold line 29 and the fold line 25 provides a second side plate 30 which is broader than the first side plate 28. The second side plate 30 is provided with an opening 31 which is large enough to permit free entrance of cockroaches. The area defined by the fold line 29 and the lateral side 23a provides a flap 32.

The wing 24 consists of a generally triangular end plate 33 and a rectangular link member 34. The end plate 33 has an opening 35 which is large enough to permit free entrance of cockroaches. The link member 34 has a slit 36 and borders the end plate 33 at a fold line 37.

Each of the openings 31 and 35 may be a single large opening of a desired shape, or at least one elongated opening of the same shape as defined in connection with the device according to the first aspect of the invention.

One end 23c of the wing 23 is provided with a recess 38 to form a projection 32a from one end of the flap 32. A notch 39 is provided in the lateral side 23a of the flap 32.

The bottom plate 27 has a coat of an adhesive agent 40 on its entire surface except for the area which is at least 20 mm distant from the edge 22a. The adhesive layer 40 is preferably covered with peelable paper which is peeled off just before use.

The device for capturing cockroaches according to the second aspect of the present invention is constructed by the following procedure. First, the wings 23 and 24 are folded at lines 25, 26 and 29 until the two flaps 32 contact each other by their inner surface. The two projections 32a are slipped into the slit 36 so as to engage the second side plates 30 and the end plate 33 by the link member 34, in such a manner that the lateral sides 33a of the end plate 33 are in contact with the inner surface of each of the second side plates 30, 30. As a result of this procedure, there is provided a cockroach trap which consists of the flat bottom plate 27, a pair of first side plates 28, 28 that are low in height and are not connected to each other, a pair of second side plates 30, 30 which are higher than the first side plates and are connected to each other, and the end plate 33 which closes the opening at one end of the second side plates. As shown in Fig. 12, this device is open at one end in the longitudinal direction of the bottom plate 27 and is closed at the other end.

In the embodiments shown above, the fold lines are preliminarily provided in the blank and the user constructs the device by himself by folding the respective portions of the blank. Alternatively, the device may be supplied in its completed form which is prepared by folding with a press or any other suitable positioning means.

Fig. 13 shows how the cockroach trap according to the present invention is used. The part of the trap defined by the low first side plates 28 is inserted into the gap E between a floor A and the bottom of a piece of furniture, whereas the other part of the trap defined by the high second side plates 30 and the end plate 33

is left outside of the gap. Cockroaches living in the gap E can be captured by using the open space between the first side plates 28.

These scuttling about on the floor A can also be captured by using the openings 31 and 35 made in the second side plates 30 and the end plate 33, respectively.

The device of the present invention has high strength against external bending or twisting forces because the first and second side plates 28 and 30 are in an erect position with respect to the bottom plate 27. The erect side plates 28 serve as a protection against the walls of a building. They also prevent the adhesive layer 40 from making direct contact with the walls.

Therefore, the device of the present invention is free from the chance of contamination of the adhesive layer by extraneous materials such as dust and dirt. The edge of the adhesive layer 40 is at least 20 mm apart from the open end of the bottom plate 27. If the forelegs of a cockroach get stuck to the adhesive layer, its hind legs are still on the bottom plate 27, rather than on the floor A, and so it is unable to move the device. The device of the present invention claims further protection from unwanted movement by cockroaches because the high second side plates 30 are in contact with the angular corner of the bottom of furniture.

Conventional cockroach trap are often moved from the intended area by cockroaches which are not completely trapped. As a result, the capturing efficiency is decreased significantly, or the device slips to an inaccessible area. However, these problems are absent from the device of the present invention and it can always be held in the desired area.

The device of the present invention is open in the part above the first side plates 28, so cockroaches can have easy access to the bottom plate 27 having the adhesive layer 40. This is another reason why the device of the invention features high capturing efficiency. As a further advantage, the user can readily check visually how many cockroaches have been captured.

The high second side plates 30 are not within the gap E, so the user has only to hold these plates in order to take the device out of the gap. This is also desired from a hygienic viewpoint since the user can dispose of the device without touching the adhesive layer 40 to which cockroaches have got stuck.

These advantages are more apparent in the embodiment shown in Fig. 12. The erect flaps 32 provide a handy means for holding the device. They are sufficiently distant from the adhesive layer 40 to avoid user's contact with the tentacles, legs or alae of a cockroach.

The second side plates 30 that are exposed from the gap E are connected by the flaps 32 and the end plate 33 conceals the interior of the device. When the device is put into the gap E, the user does not see the inside of the device and will have no unpleasant feeling.

The low first side plates preferably cover at least half of the total length of the device. It is to be emphasized here that the device of the present invention is adapted to capturing not only cockroaches living in small concealed areas but also those

scuttling around on the floor or in an open space.

The device of the present invention is not limited to the embodiment shown in Fig. 12. The end plate 33 may be omitted as shown in Figs. 14 to 16, and if they are not used, the bottom plate 27 must have margins 5 in both ends which are not coated with the adhesive layer 40 and are at least 20 mm distant from both ends of the plate so that a cockroach entering the device from either end cannot extend its hind legs beyond the device when it is caught by the adhesive layer 40.

10 Instead of combining the inner surfaces of the flaps 32 as shown in Fig. 12, they may be combined in an overlapping fashion as illustrated in Fig. 14. Alternatively, the flaps 32 may be engageably connected as illustrated in Fig. 15. If desired, the second side plates 15 30 and the flaps 32 may be connected in an overlapping fashion to form a curved contour as shown in Fig. 16. In still another embodiment, the upper edge 28a of each of the first side plates 28 may be inclined as shown in Figs. 17 and 18.

20 As will be understood from the foregoing description, the device according to the second aspect is adapted to installation in a small gap for capturing cockroaches living in that area. The device has sufficient strength to resist external twisting or 25 bending forces. It presents no hygienic problems and will cause no contamination by the adhesive layer formed on the bottom plate. If necessary, the device can be effectively used in an open space (i.e., floor).

Experiments were conducted to determine the 30 effectiveness of the device for capturing cockroaches according to the present invention.

Experiment 1

Six samples of cockroach trap were fabricated. They were in the form of a rectangular prism. Each of 35 the four side walls was provided with a plurality of openings; the base of each opening was 1 cm above the bottom plate, with the length of the longitudinal axis (l_2) being 3 cm and the angle (θ_1) between the longitudinal axis and the fold line at which the side 40 wall has been folded being 90°. The openings were arranged with separation, distance l_1 , i.e. a distance equal to the width of openings. The total area of the openings was the same for each sample, and the number of cockroaches captured by each trap sample 45 was counted.

The sample traps were made of paperboard and measured 160 mm long, 80 mm wide and 40 mm high. The width (l_1) of the openings was varied at 3, 5, 8, 12, 20 and 40 mm. The entire part of the inner 50 surface of the bottom plate was coated with a layer of adhesive agent, and an attractant was placed in the center of the adhesive layer. The six sample traps were placed in a room (ca. 10m²) at equal spacings and equally distant from two opposing walls. Thirty 55 adult *Periplaneta fuliginosa* Serville were let loose in the room, and 24 hours later, the number of cockroaches captured in each sample was counted. The same experiment was conducted with adult 60 *Blattella germanica* Linne. For each species of cockroaches, five runs of experiment was conducted by changing the order of sample arrangement and the total number of the cockroaches captured was counted. The results are shown below.

| Sample No. | Width of openings l_1 (mm) | Number of openings | Cockroaches captured | |
|------------|------------------------------|--------------------|--|----------------------------------|
| | | | <i>Periplaneta fuliginosa</i> Serville | <i>Blattella germanica</i> Linne |
| 1 | 3 | 80 | 3 | 15 |
| 2 | 5 | 48 | 15 | 18 |
| 3 | 8 | 30 | 24 | 18 |
| 4 | 12 | 20 | 20 | 16 |
| 5 | 20 | 12 | 12 | 14 |
| 6 | 40 | 6 | 13 | 15 |
| Total | - | - | 87 | 96 |

As the table shows, very few adult *Periplaneta fuliginosa* Serville were captured in Sample No. 1 having openings of a width 3 mm. At least four times as many cockroaches were captured in each of the other samples. It therefore became evident that for the effective capturing of adult *Periplaneta fuliginosa* Serville, the width of openings must be at least 5 mm. Comparison of the data for the widths 8 mm, 12 mm, 20 mm and 40 mm shows that openings whose width (l_1) was in the range of 5 mm to 12 mm were the most effective in capturing cockroaches probably because 75 these openings made cockroaches less sensitive to the danger of the adhesive agent. The data in the table also shows that the efficiency of capturing adult *Blattella germanica* Linne which were smaller than adult *Periplaneta fuliginosa* Serville was not highly dependent on the width (l_1) of openings. It is therefore clear that the device of the present invention is highly effective in capturing small cockroaches irrespective of the width (l_1) of openings.

Experiment 2

80 Series of experiments were conducted in the same manner as in Experiment 1. The only differences were as follows: the width (l_1) of openings was the same for each sample; the length (l_2) of the openings was varied at 4, 8, 12, 16 and 24 mm; and twenty-five 90 cockroaches were let loose in each run. The results are shown in the following table.

| Sample No. | Length of openings l_2 (mm) | Number of openings | l_2/l_1 ratio | Cockroaches captured | |
|------------|-------------------------------|--------------------|-----------------|--|----------------------------------|
| | | | | <i>Periplaneta fuliginosa</i> Serville | <i>Blattella germanica</i> Linne |
| 7 | 4 | 30 | 1/2 | 5 | 12 |
| 8 | 8 | 30 | 1/1 | 8 | 19 |
| 9 | 12 | 30 | 3/2 | 13 | 18 |
| 10 | 16 | 30 | 2/1 | 24 | 19 |
| 11 | 24 | 30 | 3/1 | 25 | 20 |
| Total | - | - | - | 77 | 88 |

As the above table shows, the number of adult *Periplaneta fuliginosa* Serville captured in Sample No. 8 ($l_2/l_1 = 1/1$) was less than a third of the number of 95 cockroaches captured in Sample No. 10 (2/1) or 11 (3/1). Sample No. 9 having the l_2/l_1 ratio of 3/2 was less effective than Sample Nos. 10 and 11 and could capture a little more than 1.6 times as many cockroaches as captured by Sample 7. It is therefore clear that for the effective capturing of adult *Periplaneta fuliginosa* Serville, the ratio l_2/l_1 should be at least 1.5, and the ratio of 2.0 or greater is preferred.

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The capturing of *Blattella germanica* Linn was not highly dependent on the ratio l_2/l_1 .

Experiment 3

A series of experiments were conducted as in Experiment 1, except that the distance l_3 of the base of each opening from the bottom plate was varied at 0, 3, 5, 10 and 20 mm. The other dimensions of each opening were $l_2 = 20$ mm and $l_1 = 8$ mm. Twenty-five cockroaches were let loose in each run. The results are shown in the following table.

| Sample No. | Distance l_3 (mm) | Number of openings | Cockroaches captured | |
|------------|---------------------|--------------------|--|---------------------------------|
| | | | <i>Periplaneta fuliginosa</i> Serville | <i>Blattella germanica</i> Linn |
| 12 | 0 | 30 | 6 | 12 |
| 13 | 3 | 30 | 9 | 17 |
| 14 | 5 | 30 | 20 | 22 |
| 15 | 10 | 30 | 22 | 21 |
| 16 | 20 | 30 | 17 | 18 |
| Total | - | - | 74 | 90 |

As the above table shows, Sample No. 14 ($l_3 = 5$ mm) captured more than twice as many cockroaches (adult *Periplaneta fuliginosa* Serville) as captured by Sample No. 13 ($l_3 = 3$ mm). Sample No. 15 ($l_3 = 10$ mm) was more effective. A cockroach has its head parallel to the bottom plate when it enters the device through an opening. In order to prevent the cockroach from sensing the danger of the adhesive layer on the bottom plate, the opening must be distant from the bottom plate by at least 5 mm. The efficiency of capturing adult *Blattella germanica* Linn is not highly dependent on l_3 , except that Sample No. 12 using $l_3 = 0$ mm was the least effective. The reason would be that a cockroach easily senses the danger of the adhesive layer by direct contact with its tentacles or legs. However, *Blattella germanica* Linn which is weaker than *Periplaneta fuliginosa* Serville is unable to escape from the trap once it gets stuck to the adhesive layer, and this would be the reason why the number of adult *Blattella germanica* Linn captured in Sample No. 12 is not appreciably smaller than the numbers attained by the other samples.

Experiment 4

A series of experiments were conducted as in Experiment 3, except that θ_1 was varied at 0, 15, 30, 45 and 90°. The other dimensions of each opening were as follows: $l_3 = 5$ mm, $l_1 = 8$ mm, the total length of $l_2 = 40$ cm. The results are shown in the following table.

| Sample No. | θ_1 (°) | Cockroaches captured | |
|------------|----------------|--|---------------------------------|
| | | <i>Periplaneta fuliginosa</i> Serville | <i>Blattella germanica</i> Linn |
| 17 | 0 | 7 | 12 |
| 18 | 15 | 10 | 13 |
| 19 | 30 | 19 | 18 |
| 20 | 45 | 22 | 20 |
| 21 | 90 | 21 | 21 |
| Total | - | 79 | 88 |

As the above data shows, Sample Nos. 19, 20 and 21 using θ_1 of 30° or more were appreciably more effective than Sample Nos. 17 and 18 ($\leq 15^\circ$) in

capturing adult *Periplaneta fuliginosa* Serville. This could be explained as follows: as θ_1 becomes small, a cockroach entering through an opening has a greater ease in detecting the adhesive layer by the tentacles; furthermore, the inclination of the head of the cockroach with respect to the bottom plate is small enough for the cockroach to move backward by sensing the danger of the adhesive layer positioned below its head in the direction of its advancement. A similar tendency was observed with adult *Blattella germanica* Linn, but the capturing efficiency was not highly dependent on θ_1 . As a conclusion, high capturing efficiency is obtained if θ_1 is in the range of 30° to 150° (including symmetrical shapes).

Experiment 5

Six samples of cockroach trap were prepared. They were in the form of a triangular prism. Ten openings were made only in one of the opposing rectangular side plates. Each opening was made 1 cm (l_3) distant from the bottom plate; its length (l_2) was 30 mm; its width (l_1) was 8 mm; its inclination (θ_1) was 90°; and the distance between each opening was 8 mm. The angle between the bottom plate and each of the end plates was fixed at 90°. The angle between the perforated rectangular side plate and the bottom plate was varied at 15, 30, 45, 60, 90 and 120°.

Each sample was made of cardboard, and its bottom plate measured 160 mm long and 80 mm wide. An adhesive layer was applied to the entire part of the inner surface of the bottom plate, and an attractant was placed in the center of the adhesive layer. The number of cockroaches captured in each of the six samples was counted as in Experiment 1. The results are shown in the following table.

| Sample No. | Angle between perforated rectangular side plate and bottom plate (°) | Cockroaches captured | |
|------------|--|--|---------------------------------|
| | | <i>Periplaneta fuliginosa</i> Serville | <i>Blattella germanica</i> Linn |
| 22 | 15 | 3 | 5 |
| 23 | 30 | 18 | 20 |
| 24 | 45 | 20 | 17 |
| 25 | 60 | 16 | 19 |
| 26 | 90 | 19 | 20 |
| 27 | 120 | 5 | 8 |
| Total | - | 81 | 89 |

As the above data shows, Sample Nos. 23 to 26 were most effective in capturing both species of cockroaches. Sample No. 22 wherein the perforated side plate was inclined at 15° with respect to the bottom plate was far less effective probably because cockroaches entering the trap through openings could easily detect the danger of the adhesive layers which were almost in front of their face. On the other hand, the perforated side plate was inclined at an angle greater than 90° with respect to the bottom plate as in the case of Sample No. 27, cockroaches had to climb the side plate upside down, but this was a most difficult thing to do for the cockroaches.

In view of the results of Experiments 1 to 5, the opening made in the cockroach trap according to the best embodiment of the present invention should have the following dimensions: the axis (9b) of the

opening perpendicular to the axis 9a is not shorter than 5 mm and not longer than 12 mm; the length of 9a is at least 1.5 times as long as the length of 9b; the axis 9a is inclined with respect to the line 3a (at which 5 the side plate 3 is folded d) at an angle (θ_1) in the range of 30° to 150°; the opening is distant from the bottom plate by at least 5 mm; the perforated side plate is inclined from the bottom plate at an angle in the range of 30° and 90°; an adhesive layer is formed on 10 the inner surface of the bottom plate. What is most important for the purposes of the present invention is that the opening is longer in the direction normal to the bottom plate than in the direction parallel to the bottom plate, and that the width of the opening (the 15 length of each side which is parallel to the bottom plate) is not shorter than 5 mm and not longer than 12 mm.

CLAIMS

1. A device for capturing cockroaches, which 20 comprises a bottom plate having a layer of an adhesive agent formed on the inner surface for capturing cockroaches; a pair of lateral side plates connected to the lateral sides of said bottom plate, each of said lateral side plates having a flap along its 25 lateral side and having at least one opening which provides a passage for cockroaches to enter the device and which is longer in the direction normal to the lateral sides of the bottom plate than in the direction parallel thereto; and a pair of end plates 30 connected to the end sides of said bottom plate, each of said end plates having a link member on its end portions that engages said flaps and having at least one opening which provides a passage for cockroaches to enter the device and which is longer in the 35 direction normal to the ends of the bottom plate than in the direction parallel thereto, said device being constructed by folding said lateral side plates and said end plates respectively at the lateral sides and ends of said bottom plate, connecting said flaps, and 40 engaging the same with said link members at the ends thereof.

2. A device according to Claim 1 wherein said flaps are interconnected in such a manner that their inner surfaces contact each other, the connected flaps 45 engaging said link members to form a grip.

3. A device according to Claim 1 wherein said opening has a width in the range of 5 to 12 mm and a length which is at least 1.5 times as great as said width.

50 4. A device according to Claim 1 wherein the distance between the lower side of said opening and the lateral side of the bottom plate to which the perforated side plate is connected is at least 5 mm.

55 5. A device according to Claim 1 wherein the longitudinal axis of said opening is inclined with respect to the lateral side of said bottom plate at an angle of 30 to 150°.

60 6. A device according to Claim 1 wherein the layer of said adhesive agent is covered with peelable paper which is peeled from said adhesive layer for use, when an attractant is put on said adhesive layer.

65 7. A device for capturing cockroaches, which comprises a bottom plate having a layer of an adhesive agent formed on the inner surface for capturing cockroaches; and a pair of said plates

connected to the lateral sides of said bottom plate, each of said side plates extending to one end of said bottom plate and consisting of a wide portion having a flap at its lateral side and a narrow portion which is

70 connected to the end of said wide portion and extending to the other end of said bottom plate, said device being constructed by folding said side plates at the lateral sides of said bottom plate and engaging said flaps with each other or bonding the same to each other.

75 8. A device according to Claim 7 which further includes an end plate connected to the end of said bottom plate which is close to said wide portions, said end plate having a link member which is connected to its end portion and is engageable with said flaps, said end plate further having at least one opening that provides a passage for cockroaches to enter the device.

80 9. A device according to Claim 7 wherein each of said side plates has in its wide portion at least one opening that provides a passage for cockroaches to enter the device.

90 10. A device according to Claim 7 wherein the narrow portion of each of said side plates is at least half of the entire length of said side plate.

95 11. A device according to Claim 7 wherein said adhesive layer is covered with peelable paper which is peeled from said adhesive layer before use, when an attractant is put on said adhesive layer.

12. A device according to any one of Claims 7, 8 and 11 wherein said adhesive layer is formed at least 20 mm apart from an open end of the device where no end plate is connected to said bottom plate.

13. A device according to Claim 8 or 9 wherein 100 said opening is a single relatively large opening.

14. A device according to Claim 8 or 9 wherein said opening is longer in the direction normal to the bottom plate than in the direction parallel thereto.

15. A device according to Claim 14 wherein said 105 opening has a width in the range of 5 to 12 mm and a length which is at least 1.5 times as great as said width, the distance between the lower side of said opening and the lateral side of the bottom plate to which the perforated plate is connected is at least 5 mm, the longitudinal axis of said opening being inclined with respect to the lateral side of said bottom 110 plate at an angle of 30 to 150°.

16. A device according to Claim 8 wherein said flaps are interconnected in such a manner that their inner surfaces contact each other, the connected flaps 115 engaging said link member to form a grip.